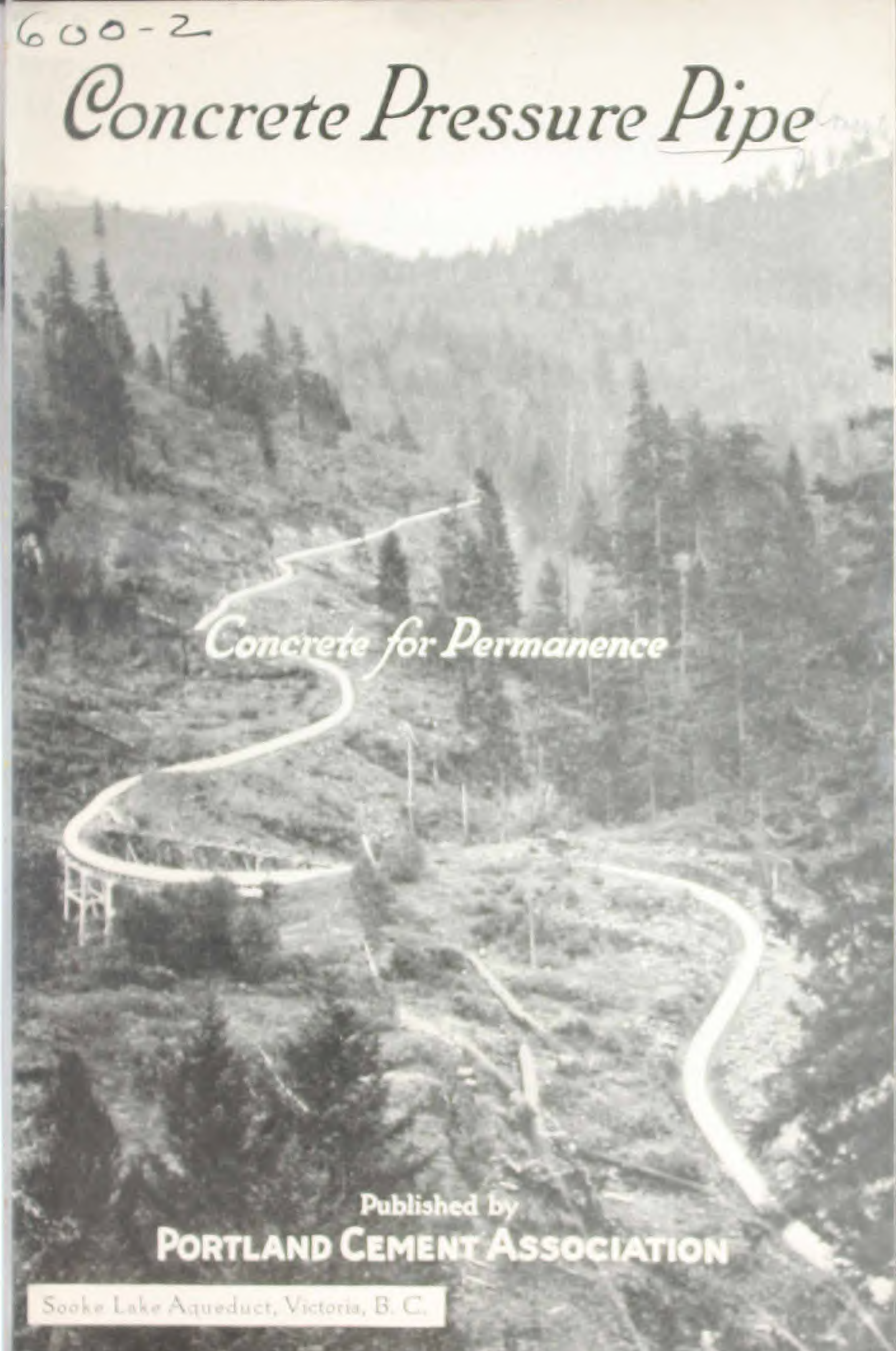
600-2

Concrete Pressure Pipe



Published by

PORTLAND CEMENT ASSOCIATION

Sooke Lake Aqueduct, Victoria, B. C.

Reinforced Concrete Pressure Pipe

Advantages

REINFORCED concrete pipe is always ready to serve its intended purpose with full efficiency. It will not dry out, rot, rust or burn. These advantages are important because the pipe suffers no impairment either in use or when not in use. Properly made, it will not leak.

Such pipe may be used under any pressure to which water pipe is usually subjected. Concrete pipe have been successfully used under heads considerably greater than 100 feet. Reinforced concrete pipe has the strength necessary to resist external pressure of the earth at any depth to which it is

Reinforced concrete pipe for power house condenser of the Consolidated Gas, Electric Light & Power Co., Baltimore, Md. This pipe is 108 inches in diameter, 9 inches thick. The sections are 15 feet long and weigh 55,000 pounds each. This pipe was laid by divers working in 15 feet of water. An idea of the size of these sections may be formed by noting the man sitting on the second pipe at the left of the front row.

practicable to place it; also the strength to resist any internal pressure to which commonly subjected. It permits of any desired alignment. Such curves as may be necessary either to conform to contour of the ground or to avoid obstructions

Reinforced concrete pipe 36 inches in diameter installed in the new sewage force main at Dallas, Tex. This main is 3 miles long.

can readily be introduced, and without in any way affecting watertightness of the pipe line. The inner surface of concrete pipe is smooth and uniform, so the friction of flow is slight.

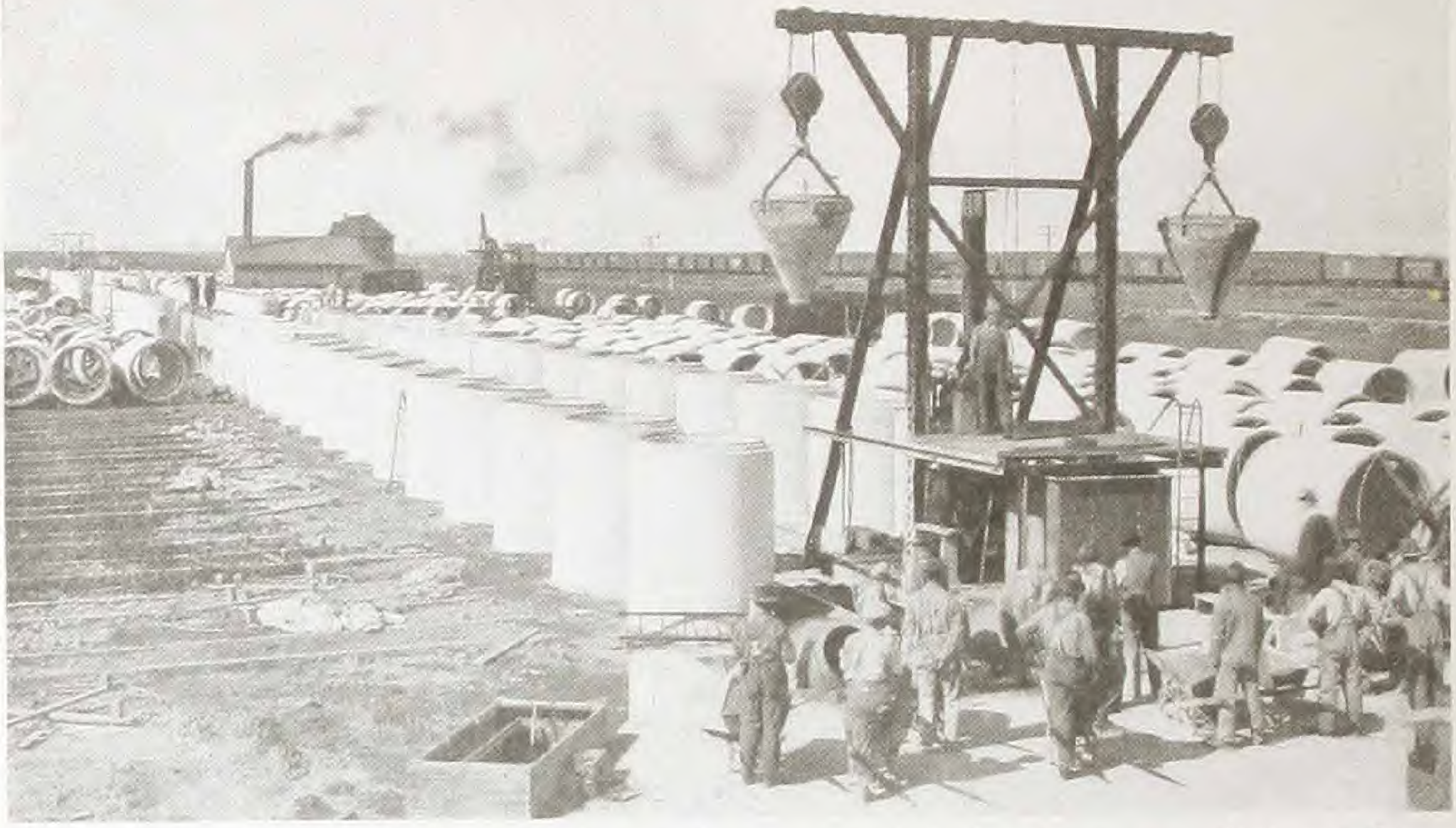
Concrete Pipe Can Be Used in Any Climate

Reinforced concrete pipe lines are giving equally satisfactory service in the extreme heat of Mexico and in the severe cold of northern Canada.

Conditions Favorable to Use

War is making such demands for plate steel and iron as to restrict the availability of these materials for most other uses.

Steel in the form of rods or mesh required to reinforce concrete pipe is usually readily obtainable. In addition, the bulk of the materials of which concrete pressure pipe are made can usually be obtained either on the site or near the work. This



Reinforced concrete pipe 66 inches in diameter and 8 feet long, manufactured for Greater Winnipeg Aqueduct. The contract in which this pipe was used involved a 10-mile line.

makes it unnecessary to transport any considerable quantity of materials, thus our present overtaxed transportation facilities are not further burdened.

Where Reinforced Concrete Pressure Pipe is Used

Many large cities in the United States and Canada are using reinforced concrete pressure pipe in all sizes from 36 to 108 inches in diameter, under a wide range of pressure conditions for water supply mains. The United States Government is using it in connection with irrigation projects. Power companies, particularly in the western states, are using it to convey water for power purposes. It is adapted to practically all conditions of service imposed by municipal water supply, irrigation or power requirements.

What They Say About Reinforced Concrete Pipe

The following letters speak for themselves:

Copy of Letter

THE CITY OF SEATTLE
Office of City Engineer

August 17, 1917

C. M. Wood, Manager,
Cement Products Bureau,
Chicago.

Dear Sir:

In reply to your request for a statement as to reinforced concrete water pipe, forwarded to me by Mr. C. N. Reitze of this city, I beg to advise you as follows:

On October 18, 1916, the City of Seattle received bids for 3,400 feet of 36-inch and 3,400 feet of 42-inch water pipe. The work consisted of two lines of pipe laid parallel with each other in the same trench. The low bids were as follows: Cast Iron Pipe, $86,818.24; Riveted Steel, $66,541.33; and Reinforced Concrete, $54,585.56. After due consideration, a contract was finally awarded to the Pacific Lock Joint Pipe Company for two lines of 42-inch Reinforced Concrete Pipe, the price paid for the work being $59,360.74.

The head on this pipe varies from 20 feet at the upper end to 90 feet at the lower end. Reinforcement consists of spirally-wound steel rods of ⅜-inch diameter, the proper spacing being secured by light steel tees slotted to receive the wire. The reinforcing is designed for a unit stress of 10,000 pounds per square inch. The shell of the pipe is 4½ in. in thickness, composed of concrete mixed 1 part cement to 1½ parts sand and 2½ parts fine gravel. One barrel of cement is figured as containing 3.5 cubic feet. Very careful tests were made of the sand and gravel and the proportions varied from time to time in order to secure the maximum density. The grading was kept very near to Fuller's

Twin line of 42-inch reinforced concrete pipe for the water supply of Seattle, Wash. These lines are now working under a 90-foot head and each pipe before being laid was tested to a 50 per cent greater head than the 90-foot service maximum required.

curve. The cement used for the first part of the work was ground so that 95% passed a 200-mesh screen. Towards the latter part of the work a cement passing 85% through the 200-mesh screen was used.

The pipe was tested to withstand a hydrostatic pressure of 1½ times the static head. All pipe showing any leakage whatever was rejected. A large portion of this pipe was made during the winter months, the temperature falling, during part of the work, to the freezing point. The contractor found, as might have been expected from the well-known fact

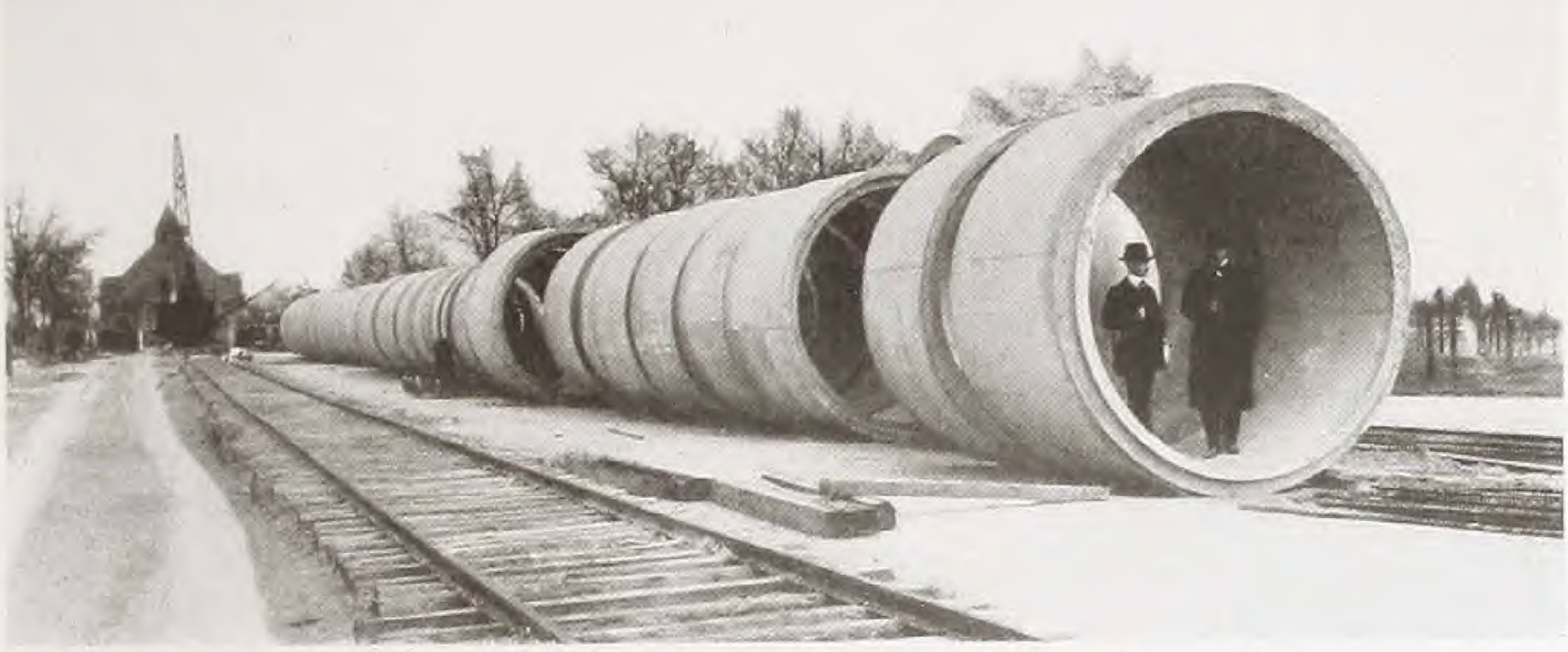
A section of pipe used in the Winnipeg Aqueduct project, which was tested for impermeability. Tests showed that under 50 pounds pressure per square inch, equivalent to a 115-foot head, leakage was only 335 imperial gallons per mile in 24 hours.

that concrete hardens very slowly, if at all, under low temperatures, that pipe made under such conditions would not withstand the test. The pipe was then cured in a chamber heated to a temperature of approximately 150 degrees, pipe so cured withstanding the test satisfactorily, except that occasional joints were rejected.

The pipe was made in 8-foot lengths. Each joint was rendered watertight by a band of copper imbedded in the pipe during construction, the jointing being completed by painting certain portions with asphalt and then filling in the joint with neat cement mortar. The asphalt painting was so arranged that on contraction the cracking of the joints would take place at a predetermined point opposite the copper band. The variation in temperature of the water carried by these pipes probably does not exceed 30 degrees.

The joints were carefully tested by hydrostatic pressure at convenient times, each section of pipe having previously been tested before being placed in the trench. Pipe was carefully bedded in concrete in order to maintain a perfect alignment and prevent cracking of joints due to

settlement. It was intended that a careful test be made of the entire pipe line before the pipe was placed in service. This test, however, was unfortunately not made, but I believe that the pipe, as constructed, will show a very small amount of leakage indeed, inasmuch as no leaky sections were permitted to be used and very few of the joints proved defec-



Sections of 108-inch reinforced concrete pipe made for the Gunpowder water supply for the City of Baltimore. This pipe is at present supplying all of the water to Baltimore and is working under a head of 85 feet. The pipe line consisted of 6,000 feet of 108-inch pipe and 2,700 feet of 84-inch pipe.

tive when tested, and all of such defective joints were properly repaired. I believe that this pipe line is one of the most successful concrete pipe lines ever constructed. This result was obtained by a very careful watching of the minutest details of construction. We had also the benefit of very hearty co-operation on the part of the contractors, who were as anxious as we were to secure the best possible results.

A number of interesting questions arise concerning the design and construction of such pressure pipe lines. These questions, however, will be discussed later in a paper in which Mr. T. H. Carver, Water Supply Engineer in charge of this work, expects to present before the American Society of Civil Engineers.

Very respectfully,

(Signed) A. H. Dimock,
City Engineer.

Copy of Letter

City of Fort Worth
Fort Worth, Texas

October 17, 1917

Coleman Meriwether,
Mgr., Cement Products Bureau,
Chicago.

Dear Sir:

Answering your request for data covering the 6.2 miles of 36 and 48-inch reinforced concrete conduit of lock joint pipe laid for us by the Lock

Joint Pipe Company, I beg to advise that same has given entire satisfaction.

We found it many times cheaper than cast iron or steel pipe and for our purposes (our maximum pressure being between 25 and 30 pounds) just as good.

First tests on the entire line showed the leakage to be about one-third of the specified allowable leakage of 36,000 gallons per 24 hours. This leakage was measured continuously for practically a week and in continuous stretches of as much as 36 hours, water being measured by barrels and checked by certified water meters.

We have not made any recent tests on leakage, but will be pleased to do so for you; however, I am certain that whatever leakage did occur will have very materially diminished by now, due to service.

This pipe was made in 8-foot sections at a point accessible to our work, and laid in a trench with from two to sixteen-(16) foot cover.

Yours very respectfully,

(Signed) F. J. Von Zuben,
City Engineer.

Copy of Letter

James H. Fuertes
Consulting Engineer and Sanitary Expert
140 Nassau Street, New York

October 27, 1917

The Portland Cement Association,
Coleman Meriwether, Mgr.
Cement Products Bureau,
Chicago, Ill.

My Dear Mr. Meriwether:

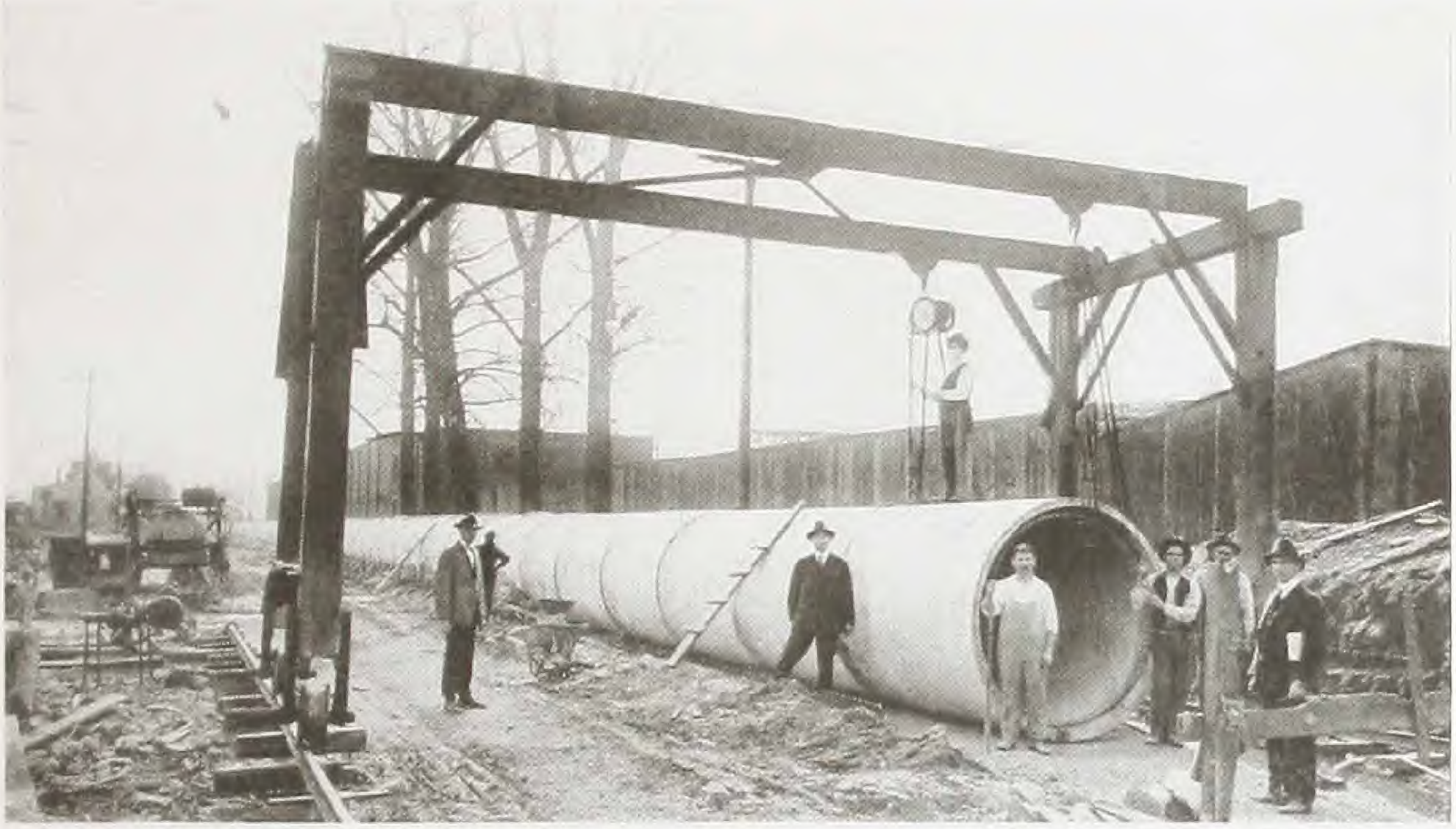
I have your letter of October 13th asking for an expression of my opinion concerning the reinforced concrete force main at Dallas, Texas. This force main was provided for the conveyance of sewage from the pumping station to the sewage disposal plant in the valley of the Trinity River; the plans for the works were made in my office and the works were carried out under my general supervision as consulting engineer for the city.

This force main, which was 14,400 feet long and 36 inches internal diameter, was substituted for a 36-inch cast iron force main which had been provided for in the original plans, at a saving to the city of Dallas of about $21,000.

The reinforced concrete pipe was manufactured and laid by the Lock Joint Pipe Co., and was provided with their type of copper expansion joints at the end of every monolithic 8-ft. length of pipe.

The specifications under which the pipe was constructed contained among other provisions a test for leakage under full operating heads, the allowable leakage for the 14,400 feet being limited to 22,000 gallons

per 24 hours. The final test made Dec. 4th, 1916, showed a total leakage of 17,724 gallons for the whole line. The heads during the tests ranged from 15 ft. to 78 ft., and the reinforcement was proportioned for the heads to be expected at the different points of the line. The test was made with clean water. After placing the pipe line in service for the delivery of sewage to the disposal works, the leakage apparently diminished considerably and the discharge through the pipe line indicated a



Laying reinforced concrete pipe for the Frankford intercepting sewer, Philadelphia, Pa. This pipe is 66 inches in diameter and the line, which is 8,000 feet long, works under a head of 30 feet. A fill was placed over the pipe shown in the picture after laid.

larger flow than had been expected, due to the great smoothness of the interior of the pipe. Since the line has been in service I have heard no unfavorable comments as to its behavior and, although I have not personally inspected its operation, feel sure that any unfavorable conditions would have been reported to me promptly.

I will state further that the Lock Joint Pipe Co. is now constructing for the Greater Winnipeg Water District, for which I am consulting engineer, nearly ten miles of reinforced concrete pressure pipe to work under heads of from 30 to 100 feet, this pipe line having an internal diameter of 5 ft. 6 in. About 45 per cent of this pipe line will be completed during the present year. It is of the same general character as the Dallas force main, except that the pipes are made in 8-ft. lengths with copper expansion joints at the end of each 8-ft. length of pipe. Tests of individual lengths of pipe, which are made frequently on the ground, show that the leakage to be expected in this large line will be no more than would be expected in a well laid cast iron pipe line of equal dimensions.

Very truly yours,

(Signed) JAMES H. FUERTES.

Copy of Letter

CITY OF VICTORIA, B. C.
City Engineer's Department
Victoria, B. C.

October 16, 1917

Coleman Meriwether,
Care of Portland Cement Association,
Chicago.

Dear Mr. Meriwether:

In 1913 the City of Victoria awarded a contract to the Pacific Lock Joint Pipe Company for the construction of 27 miles of 42-inch reinforced concrete pipe, for the delivery of water from Sooke Lake to the Humpback Reservoir.

The pipe was manufactured in 4-ft. lengths, with a shell of 3 in. in thickness. The reinforcement used in the flowline was style 6, triangular

Two views of reinforced concrete pipe used to convey water from Sooke Lake to Humpback Reservoir for the city water supply of Victoria, B. C. This line is 27½ miles long. One of the siphons shown works under a head of 94 feet; the other under a head of 60 feet. The front cover shows another view of this pipe line.

mesh, manufactured by the American Steel & Wire Company. Square steel bars were used for the ring reinforcement of siphon pipe. Six 1⅜-in. square bars were used longitudinally, and the ring reinforcement was spaced by light longitudinal wires, so that it would not be moved when tamping the concrete.

Three special bevel pipes were used in laying the curves made by dropping the spigot ring on one side to give ¾, 1½ and 2¼-in. taper in

the diameter of the pipe. These bevel pipes made all the curves of the line layout with a limiting bend of 3 degrees at the joints without leaving any appreciable roughness.

The siphon pipes were made 4½ inches in thickness, and were subjected, in some cases, to a head of 95 ft.

Steam was used for the quick curing of the pipe in order to economize in the number of forms and yard space.

The interior surface of the pipe was very smooth. The pipe was stored in the yard for two weeks or more, depending on weather conditions, before being used.

The location of the pipe line was in a rough, hilly country, thickly forested with Douglas fir, and the pipe is laid on a bench cut in the side of the mountain and without any covering.

The pipe is laid on a grade of one in one thousand.

The work was commenced in May, 1914, and completed in May, 1915.

The question of taking care of the expansion on the pipe line caused some anxiety, and the contractor at first installed some copper diaphragm expansion joints with no appreciable effect, and they were discontinued. The engineer's idea was to let the cracks develop where they might and then take care of them if necessary, as it was impossible to predict their location.

The pipe line has been in use for two years, and with the exception of one small slide—when twelve lengths of pipe were carried down the hill—and two or three breakages, caused by loose rock falling on the pipe, and some contraction during the winter months, caused by sudden changes in the temperature, which resulted in a number of small leaks developing, but which on the temperature becoming normal again took up, we have had no trouble. There were also a few leaks on some of the siphons, in one instance caused by settlement of the concrete trestle. These leaks have now been taken care of and the pipe is at the present time giving good service.

Inverted siphon of the Boulder development of the Eastern Colorado Power Company. Built of reinforced concrete pressure pipe.

In the original contract tenders were called for wood, reinforcing concrete and steel pipe. It was decided by the Consulting Engineer

that concrete should be used, and his decision has, I consider, been justified. Reinforced pipe is, in my opinion, the most satisfactory material to use for work of this description. It is more permanent, and in a country heavily timbered there is not the risk of damage being done to the pipe from fire that might occur if wood had been used.

Yours very truly,

(Signed) C. H. Rust,
Water Commissioner.

Copy of Letter

The Water Commission
of the
City of Pendleton, Oregon

January 18, 1916

Messrs. Bent Brothers,
Los Angeles, Cal.

Gentlemen:

The sixteen miles of 2-ft. (average) concrete pipe which you built for this city in 1913, bringing a new water supply to the city's reservoirs, continues to be an entire success. The work was done by you under contract at a saving to the city of many thousands of dollars over other types of conduit we had under consideration. The work was prosecuted through winter and summer conditions, and although containing several miles of reinforced concrete siphons, under heads of 35 to 90 ft., has operated successfully from the day water was turned in.

Yours truly,

Pendleton Water Commission,
By J. T. Brown, Chairman.
By C. P. Strain, Clerk.

Copy of Letter

Monterey Water Works and Sewer Company, Ltd.
Estanzuela Water Supply Conduit

Monterey, Mexico, Nov. 19, 1908

Mr. Arthur S. Bent,
Los Angeles, Cal.

Dear Sir:

I have much pleasure in stating that the eleven miles of 22 and 25-in. concrete pipe line you put in for us has proved to be a very satisfactory and successful piece of construction, and I do not think there is any finer work in the Republic of Mexico. We have very carefully tested every part of the 20 kilometers of pipe under pressure, and find that it is absolutely watertight. The test was a particularly severe one and proved the excellent quality of the workmanship.

Yours faithfully,

(Signed) G. R. G. Conway,
Chief Engineer.

Copy of Letter
DEPARTMENT OF THE INTERIOR
United States Reclamation Service
Washington, D. C.

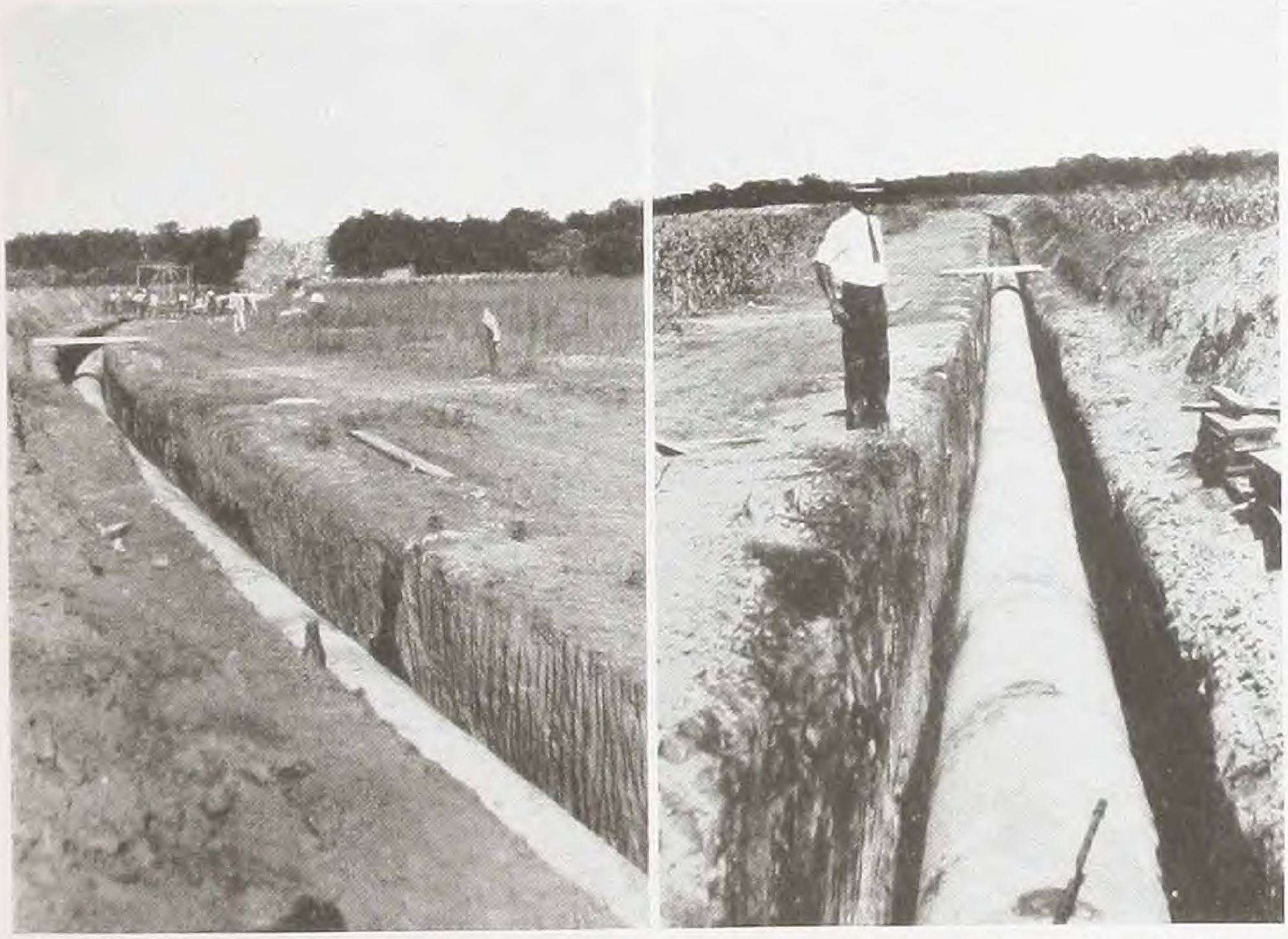
August 7, 1917

C. M. Wood, Manager,
Cement Products Bureau,
Chicago, Ill.

Dear Mr. Wood:

Your letter of August 3 has been forwarded from Urbana. I am putting it in the hands of some of our men here with a view to getting together the data which may be of value.

In general, our experience with cement pressure pipe has been favorable, everything depending, of course, upon the skill and care used in



Reinforced concrete pipe line built of 48-inch pipe for the city of Fort Worth, Tex. This line is 3 miles long and when finished was satisfactorily tested under a 65-foot head with but insignificant leakage. This illustration shows that reinforced concrete pipe is equally applicable to straight or curved pipe lines.

manufacture. In localities where it is difficult to obtain iron pipe and particularly where conditions of transportation have rendered the use of such pipe impracticable, we have resorted to the use of reinforced cement pipe and have had such excellent results that its use has been extended to points where we might have obtained iron pipe under normal conditions.

Cordially yours,
(Signed) F. H. NEWELL.

Construction Requirements

Manufacturing requirements involve properly graded aggregates, properly proportioned, mixed and placed. Proportions of the concrete mixture should be 1:1½:2½. This means 1 sack of Portland cement to 1½ cubic feet of well-graded, clean sand, to 2½ cubic feet of clean, well-graded pebbles or

Ten miles of reinforced concrete pipe in storage, built for the water pipe line supplying Longmont, Colo.

broken stone ranging from ¼ to not exceeding ¾ inch in greatest dimension. This will insure watertight pipe. After concrete has been properly mixed and placed, the finished pipe must be protected to prevent rapid drying out of the concrete—in other words, to prevent loss of any of the water used in mixing, so that the concrete may harden normally in the presence of moisture. Steam curing of pipe is certain to produce a better and more nearly uniform product.

If for any reason steam curing of pipe is not practicable, the pipe should be protected from rapid drying by some suitable covering, which must be kept wet daily for two weeks after

the pipe have been formed. They can then be allowed to acquire additional strength in the storage yard until thirty days old.

Reinforcing

Strength is secured by embedding proper reinforcing in the concrete when placed. Steel bars, or cold-drawn wire mesh, may be used. Working stresses for the former should be 10,000 pounds per square inch and for the latter 12,000 pounds.

Joints

Various companies which specialize in manufacturing reinforced concrete pipe have specially-designed joints to insure watertightness or employ special methods in forming joints. A list of manufacturers of reinforced concrete pressure pipe is given on this page. Correspondence with them is suggested.

Manufacture on the Site

Water or power developments requiring reinforced concrete pipe are of sufficient size to warrant a manufacturer moving the required manufacturing plant to the site of the work if his plant is not near enough to the job to enable shipping pipe from plant to the site of the work. Therefore, distance from a commercial plant is no obstacle.

Manufacturers of Reinforced Concrete Pipe

Bent Bros., Central Building, Los Angeles, Cal.
Canada Lock Joint Pipe, Ltd., Union Bank Building, Winnipeg, Man., Canada.
Core Joint Concrete Pipe Co., Munsey Building, Baltimore, Md.
Independent Concrete Pipe Co., 101 North West Street, Indianapolis, Ind.
Lock Joint Pipe Co., 165 Broadway, New York, N. Y.
Pacific Lock Joint Pipe Co., Tacoma, Wash.
Reinforced Concrete Pipe Co., Los Angeles, Cal.
Utah Lock Joint Pipe Co., Salt Lake City, Utah.

Let Us Help You

The Portland Cement Association will be glad to co-operate with engineers, contractors, officials of municipalities or of any projects contemplating the use of reinforced concrete pipe with a view to helping them obtain the best results in the use of such pipe. This service is free and incurs no obligation.

Concrete Pipe sewers are in satisfactory use in hundreds of cities.

Concrete Drain Tile is reclaiming millions of acres of swamp lands.

Our booklets "Concrete Sewers" and "Concrete Tile for Land Drainage" will tell you about uses of other kinds of concrete pipe. Write for your free copies.

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